



# WOODS HOLE OCEANOGRAPHIC INSTITUTION

*Applied Ocean Physics and Engineering Department*

June 4, 2014

Dr. Theresa Paluszkiewicz  
Office of Naval Research, Code 32  
875 N. Randolph Street  
Arlington, VA 22203-1995

Dear Dr. Paluszkiewicz:

Enclosed is the Final Report for ONR Grant No. N00014-10-1-0802 entitled "Mooring Operations and Cruise Support for the University of Miami Project: Impact of Typhoons on the Pacific (ITOP)," Principal Investigator, Mr. John Kemp.

Sincerely,

A handwritten signature in black ink, reading "Shirley Barkley", is positioned above the printed name and title.

Shirley Barkley  
Administrative Associate II

Enclosure

cc: Administrative Grants Officer  
Defense Technical Information Center  
Naval Research Laboratory  
Grant and Contract Services (WHOI)  
AOPE Department Office (WHOI)



# Mooring Operations Support for the University of Miami Project: Impact of Typhoons on the Pacific (ITOP)

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## INTRODUCTION

Dr. Hans Graber at the University of Miami requested the Woods Hole Oceanographic Institution's (WHOI) expertise in the design, deployment, and recovery of two, deep-water EASI-ASIS surface moorings. The moorings were deployed for a period of three months in the Western Pacific as part of the Impact of Typhoons on the Pacific (ITOP) Experiment. The work was conducted from the Research Vessel (R/V) Roger Revelle out of Kaohsiung, Taiwan.

## OBJECTIVE

The overall objective of our work was to conduct a mooring analysis of the Miami design to ensure the moorings could survive a typhoon. Secondly, WHOI personnel took the lead during the deployment and recovery operations of the deep water instrumented surface moorings (Figure 1)

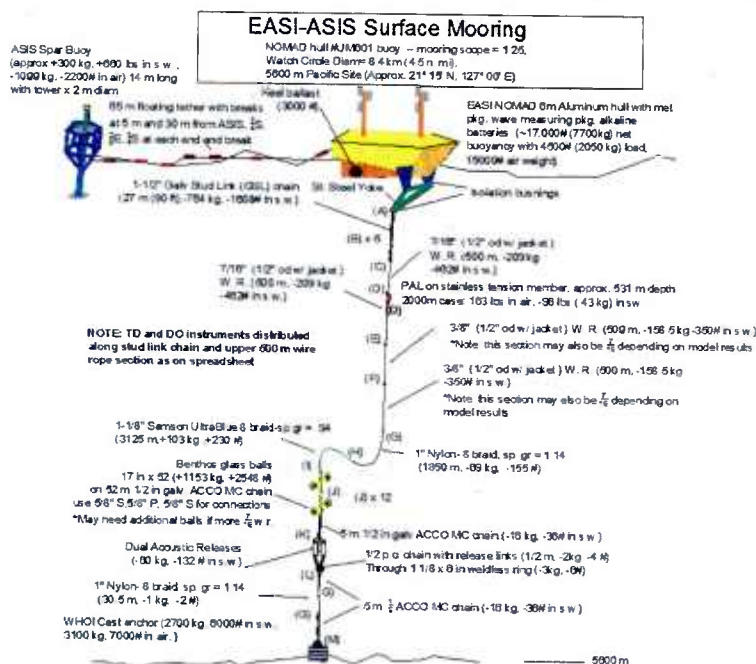


Figure 1 EASI/ASIS Mooring to be used in ITOP –Summer 2010

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## APPROACH

To ensure the moorings would survive the expected wind/waves from a typhoon, a numerical analysis (Figure 2) of the Miami mooring design was conducted using the WHOI Cable. This work was done by Mark Grosenbaugh at WHOI. We used the following reference for waves: “An Observed Extreme Large Wave” by Doong et al. published in the 2008, Taiwan-Polish Seminar on Coastal Protection. This publication gave measurements of an extreme wave with amplitude of 17 meters recorded during Typhoon Krosa in 2007. The period of the wave was 16.2 seconds.

For currents, Mark generated a “storm-driven” profile with 1 m/s at the surface and decreasing to 0.12 m/s at the bottom. Current profile data from a ship mounted ADCP was used, but corresponded to less than a day of data and was difficult to interpret.

For wind, a sustained wind speed of 25 m/s was used. Data recorded during the typhoon gave a maximum sustained wind speed of 22.2 m/s and gusts of 33.3 m/s.

The only major change was that the anchor should weigh at least **8250 lbs** in seawater in order to withstand the maximum possible wave event.

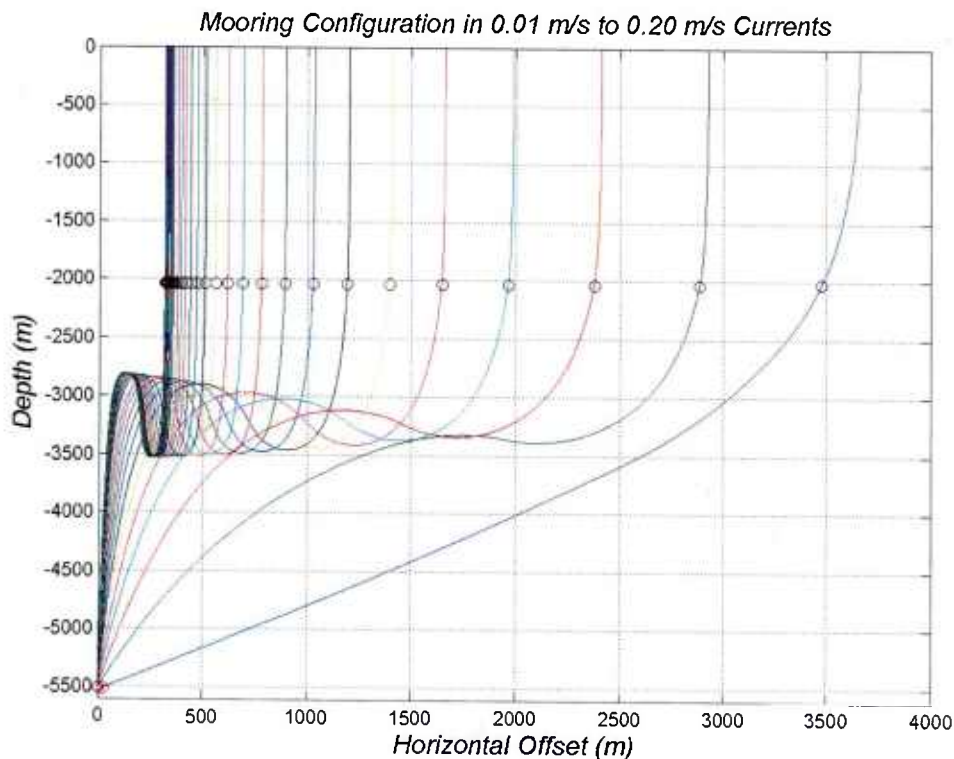


Figure 2. Black circles represent wire-rope/nylon-rope junction and red circles represent top of the glass balls.



## WORK COMPLETED

The two mooring systems were successfully deployed by the R/V Revelle in the summer of 2010 (24 July – 13 August). The anchor deployment locations (approximately 177 km (95 n. mi) apart) were surveyed in as follows (Figure 3):

EASI/ASIS 2 (North):

21 deg 14.062' N

126 deg 57.884' E

5608 m water depth

EASI/ASIS 1 (South):

19 deg 37.682' N

127 deg 15.0064' E

5512 m water depth

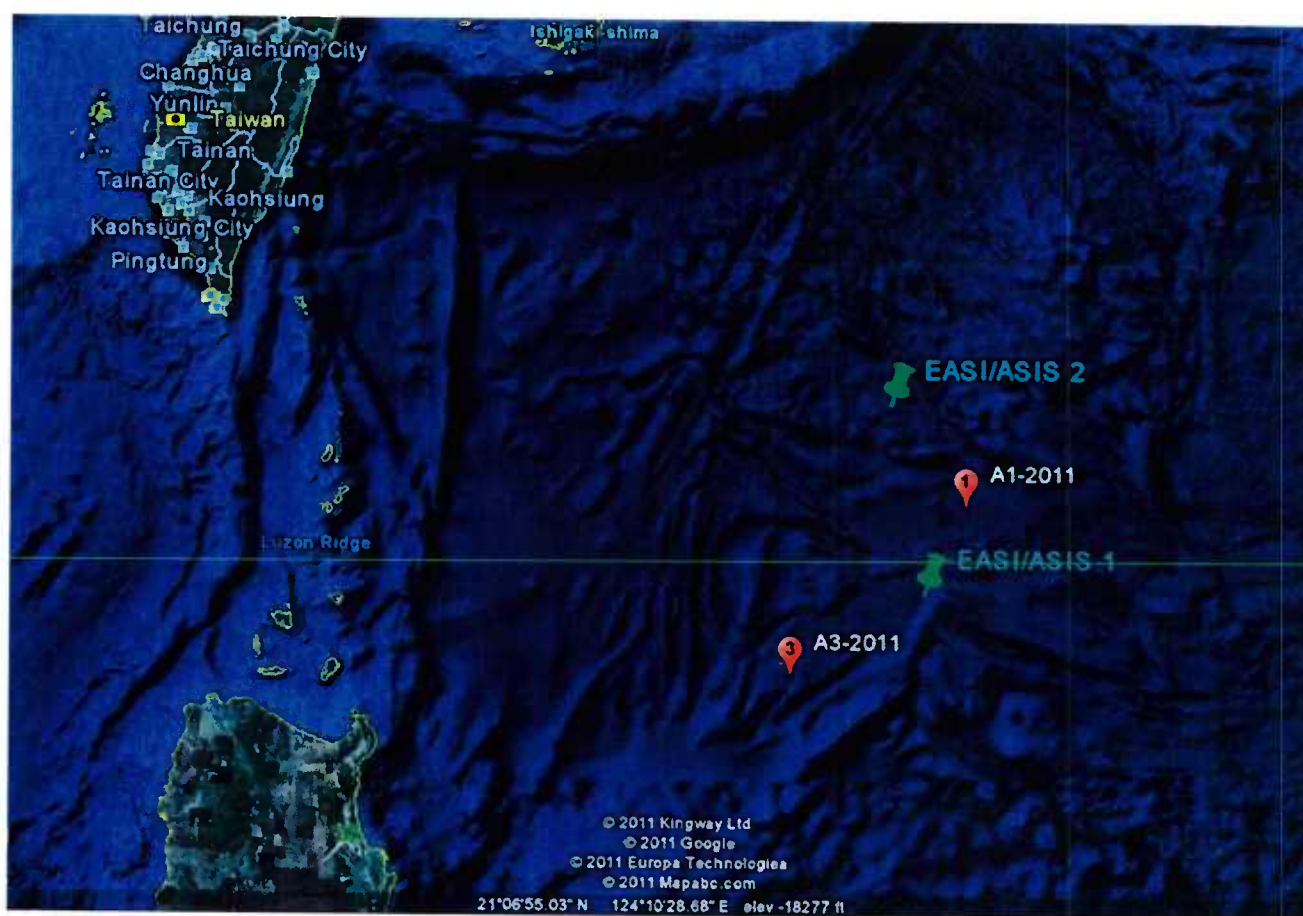


Figure 3. Mooring Locations

The ITOP surface moorings were successfully recovered by the R/V Revelle in the spring of 2011 (2 March – 21 March).



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